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Volume XXVIV, Number 1 Spring 2005 installed a ceiling hoist system, which lifts the 160-pound wheel halves into and out of the washer with no physical strain on the individual. It also allows members to guide wheels effortlessly through the shop with minimal physical exertion. Shop personnel then located an ultrasonic washer, which reduced the labor needed to clean the tie bolts from 30 minutes to 30 seconds (the time required to load the washer). The washer also cleans the bolts to NDI standards the first time, every time.

The two-person, manual torque procedure was replaced by the Wheel Assembly Torquing System—a machine that hydraulically lifts the W/T assembly and allows one person to mechanically torque the entire assembly in less than 2 minutes. The new torque system automatically applies the prescribed torque simultaneously to two tie bolts opposite one another and eliminates human error and fatigue. An additional, computermonitored servicing cage was added to allow for the concurrent servicing of tires, which turns off automatically when complete. This allows personnel to roll the W/T assembly into the cage, press start, and move on to the next buildup.

After a thorough *leaning out* of the buildup and teardown processes, the team redefined its relationships with outside agencies. One of the most labor-intensive steps (and the leading cause of injury to personnel and damage to equipment) in the lengthy process involved transporting the wheel halves and tie

bolts to NDI. The solution to this problem was quite simple: instead of bringing the items to NDI, members set up a station in the new facility and enabled NDI personnel

to perform their inspections in the W/T Section. The wheel halves are now delivered directly from the washer to an NDI station via the hoist. In addition to eliminating damage and injury, this innovation allowed W/T technicians to remain in the work area and eliminated a major inefficiency from the process.

With a new facility and a more efficient process, asset distribution then remained the only issue. This challenge was met by establishing a consolidated supply point within the facility and submitting a work order to Civil Engineering to construct an overhead mezzanine with a service elevator for storage of built-up assemblies. When a customer orders an item, a technician walks upstairs, rolls the asset to the elevator, and lowers it to the shop floor. There is literally no wait time.

The airmen on the floor who saw a better way were the backbone of this effort. By utilizing teamwork and initiative, Team McChord developed a process that is the benchmark for Air Mobility Command.

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High-Altitude Intercontinental Precision Airdrop: A Revolution in Mobility Affairs (Could AMC Learn from the B-2 PGM Model?)

Major Peter A. Garretson, USAF

The union of precision-guided munitions (PGM) and stealth technology has brought about a revolution in military affairs that has affected the way we conduct warfare dramatically. In a recent visit to Dover AFB, Delaware, Secretary of the Air Force James Roche noted that with just a few B-2 aircraft armed with PGMs a small number of aircrews could carry out most any off-the-shelf war plan. Imagine several long-range intercontinental bombers launched from the continental United States (CONUS) delivering enough ordnance to have a strategic impact in just one sortie. Could such a model be expanded to airlift platforms? Why not?

Capability currently exists for strategic airlift assets to deliver airdrop loads from CONUS to overseas locations. These same assets are capable of precision airdrop. This concept is similar to—but not exactly—the scenario described by Roche. B-2s deliver explosive ordnance—airlift platforms generally do not. So why use strategic airlift assets to carry out an airdrop mission with impact at the strategic level?

Mobility may be less glamorous than dropping bombs, but airdrop has proven vital during Operations Desert Shield; Desert Storm; Iraqi Freedom; and particularly, Enduring Freedom. Airdrop can provide the sole method of resupply in a landlocked theater of operations and is likely to become even more critical in future conflicts given increases in range, speed, and responsiveness.

If Enduring Freedom and Iraqi Freedom are decent indicators, we can expect operational plans to be carried out by

geographically dispersed, highly mobile land units that consume expendable material as fast as they move. Future wars likely will resemble Iraqi Freedom in that they are waged with comparatively small numbers of US troops moving across vast distances without completely secure supply lines. Future operations will take place in areas where land-based supply lines are highly vulnerable to disruption as experienced during Iraqi Freedom. These attributes make aerial resupply an attractive prospect.

Tactical airlift aircraft require a significant in- or near-theater infrastructure to be built, seized, borrowed, or even leased. Transloading from strategic aircraft adds complexity, slows velocity, and multiplies the number of sorties. Building airfields is not cost-effective, seizing airfields has risks of its own, and borrowing or leasing becomes more difficult as basing options dwindle and fall victim to the winds of political and public opinion. Fixed bases also must be defended and forces tied down for this task. Further, operating airfields on foreign soil is increasingly risky with the ever-increasing danger of manportable air defense systems. An option not requiring fixed overseas bases or airfields would have appeal.

The argument can be made for intercontinental precision airdrop based on these trends. How then would it be accomplished? Let us look at some options:

 One approach would be to develop this capability with current airframes and packaging systems. This pragmatic and useful

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approach is being pursued by the Joint Precision Airdrop System (JPADS) Team, which already has demonstrated significant success with global positioning system (GPS)guided parafoils dropped from altitudes as high as 25,000 feet. Pragmatic as it is, approach ultimately is limited by the platforms already in place, which were designed and optimized for a different mission. For instance, using multiple air refuelings, a current strategic airlifter could deliver JPADS loads directly into the theater, but this is an inelegant solution. No current airlifter is stealthy, all are comparatively slow, and each would require multiple air refuelings, which add stress, complexity, and additional points of failure to an already dangerously long duty day, all to deliver, at most, 36 pallets of equipment (C-5) or 18 (C-17). Then, too, such loads cannot be rearranged easily, if at all, and the tremendous rigging complexity, manual actions required, and lack of oxygen and low temperatures make the cargo compartment a dangerous place to work.

• Another approach often used by the Air Force is to build a system from scratch, specifically to meet a given mission—in the process designing out exactly such legacy problems. This is done by imagining what capability that does not exist today but one that would significantly increase our advantage and then designing the ideal force structure necessary to meet this capability; study its utility and feasibility; and hopefully, program it into future budgets. In this way, many cumbersome aspects inherent in the former method can be eliminated by intelligent design: complexity of rigging, pressurization complications, center of gravity and airspeed complications, difficulty shifting around loads, mission complexity, and insufficient stealth, range, and payload cease to be complications because we design them out.

What then are the critical components to such a capability? First, a precision-containment system must be created; second, a suitable delivery system must be designed; and finally, an information infrastructure must be created to make use of it. The ideal containment system would be a rapidly sealable aerodynamic container made of low-cost material, coupled with an inexpensive, expendable high-altitude, low-opening (HALO) guidance and parachute package. The ideal delivery system would be low-observable, intercontinental, high speed, and multipurpose. The ideal information infrastructure would link users on the ground to aircraft and inventory in the air. What follows is a vision of what high-altitude intercontinental precision airdrop might look like in the not too distant future.

It is 2025. Our future aerial porter accepts the tailored, daily expendable packages from the Army user. A small, field-deployable unit vacuum shrink-wraps the items and wraps them in a thin but high-tensile-strength Kevlar expendable harness. The package is then wrapped in Tyvek wrap, which comes in a standard roll. It is zippered together to the appropriate length, and one of several standard-sized circular or hemispherical ends are zippered or laminated on. Air is then used to inflate it before it is filled with fast-drying, impact-protective foam that fills out its aerodynamic, bomb-like shape. A wireless radio card is affixed giving an exact inventory of the device and user and delivery information, as well as its weight and fragility.

This airlift *dumb bomb* is now affixed to a low-cost tail cone that supports simple GPS-guided, glide-bomb fins and a parachute by means of the Kevlar harness. The radio card tells the tail cone how to calculate proper deceleration. Despite its

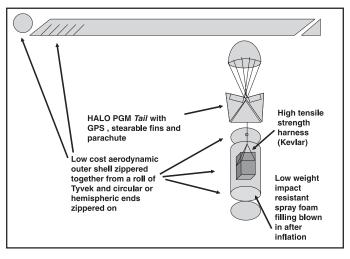


Figure 1. HALO Pack

sophistication, the use of common commercial materials and the low cost of GPS and radio-controlled model aircraft technology means the end cost is far below the cost of pallets, chains, devices, and netting.

Our aerial porter places the airlift bomb face down on the coatrack loader and then drives it out to the jet. The jet of 2025 is quite different from previous airlift platforms. First, it is quite a bit larger with a huge, intercontinental stealth flying wing. Second, because it is a span-loader, a blended-wing body, it has no fuselage and is loaded across the wing. Third, because there are no pallets to push, all cargo is loaded from a mobile coatrack to an automated coatrack not unlike devices used at your local drycleaner. There is also no paperwork—a wireless local area network (LAN) automatically calculates maximum takeoff weight given predicted environmental conditions and mission profile, updates the load plan, and loads all allowable payloads in accordance with the air-tasking order.

About that time, the aircraft commander arrives at the jet, although he does not have to. The jet can be piloted remotely via satellite, but this is a currency sortie for him, since pilots are still required for countries that do not allow unmanned overflight. AMC/A37V still requires pilots when dropping or exfiltrating troops. The flight deck he steps onto is a removable (and ejectable) module with a common suite of avionics that can *plug and play* into this aircraft, as well as a faster, high-altitude, hypersonic version that is used when loads are smaller but response time is more critical. The avionics suite allows our pilots to maintain one type rating—reducing training costs.³ However, in most cases, the tremendous weight of his instrumentation, life support, and creature comforts could be used for additional payload or fuel.

He places his mission planning tablet computer into a secure cradle, and the flight management system immediately displays his mission profile in clear graphics and all sources of potential problems: weather, terrain, special use airspace, and other aircraft. Takeoff and landing data are calculated using environmental conditions pushed to the jet from the weather server on the wireless LAN, and center-of-gravity conditions are calculated by the *coatrack* and wireless radio cards on individual pallet bombs. The pilot looks at his graphical situational picture, verifies that all parameters and systems show green on the mimic display, and then presses verify to file a flight plan wirelessly. One button

starts and configures the aircraft for taxi and takeoff, and off he goes.

It is a lousy night, so he is happy he has the full-time artificial visual flight rules, panoramic heads-up display, which provides an outside picture by fusing several sensors (millimeter wave radar, infrared, visual) with a computer-generated landscape based on a laser-ring gyro inertial navigation system/GPS position and terrain and map model. The pathway in the sky has simplified currency requirements, since the aircraft is entirely autonomous of any non-GPS navigational aids, and the Enhanced Vision System⁵ means that he is never really in instrument conditions where he cannot see the ground or runway. He chuckles, listening to the old guys in the Dadaelians talk about diverting for weather—nobody he knows has ever done that.

Not that he has much opportunity to land at fields other than his home station; since the linkage of an intercontinental *bomber* with HALO airdrop, there is a much reduced need for foreign airbase support. The reduced need to land anywhere also means that the aircraft could be built larger (maximum payloads ranging from 300,000 to 1 million pounds with wingspans as large as 330 feet) with only a limited number of bases capable of supporting such large aircraft.

Such size, range and loiter time, and fuel load, as well as the wide range of speeds offered by oblique wing geometry, have made it attractive for dual-use missions, such as aerial refueling and an airborne platform for sensors and C2 apparatus. The modular nature of its design allows any number of sensors and communications equipment to be affixed to the aircraft to refresh the common operational picture (COP) with airborne or ground radar or imagery or to serve as an intheater *satellite* for relay of electronic communications. Or, just as quickly, multiple boom modules can be affixed that turn it into a very capable multiplepoint refueler. Thankfully, those long missions usually are done remotely, mercifully, leaving these shorter vanilla legs for such currency missions as today.

Once his jet reaches altitude, the huge wing actually pivots to fly obliquely—this allows him to fly at a faster speed with less drag, making the trip much shorter. Once he arrives at the area of responsibility, he swivels back to become a huge motorgliding wing to stay stealthily at a very high altitude and loiter for the longest possible time. This allows him to stay high above the threat, even if it could see him.

On the way, he amuses himself by watching the mission sequence and configuration screen change and change, as users update their requirements. His target sequence is driven by a common operational picture that securely monitors and reports the status of all expendables by operational units, minute by minute, as well as the exact spots where the ground units want the packages placed. Like modern department stores, the inventory on his jet is a masterpiece of just-in-time warehousing, to supply on-demand airlift, much like a close air support asset orbits waiting for a request. Some packages on his jet are general—fuel; bullets; water; gas; oil; repairs; meals, ready to eat. Others are more specific to the units. The commanders on the ground constantly scrub the order of battle and the air-tasking order to determine the optimal sequence of supply.

The first sequence is now finalized, and the various coathanger loaders move the appropriate package into position for drop and program the precision tail cones with the GPS coordinates to hit the altitude of the ground and the requested altitude for chute opening. One after another, the on-board targeting computer releases each as it approaches the optimal place to ensure the smallest circle of probable error. This is a typical delivery mode: HALO. The pilot hears the faint buzz of the coat-hanger loaders whirring as they move the appropriate containers into position but never notices any significant change in the center of gravity, despite the fact that packages are being dropped from several points near simultaneously.

Each of the inexpensive tail cones correctly guides its container to its mark and opens the parachute so it makes a soft landing and is recovered by friendly forces. They cut through the Tyveck and foam and get the gas, water, or tools they may have requested only minutes ago. Some critical packages incorporate a self-destruct or beacon for destruction devices should it malfunction and fall into enemy hands. But no such mistakes happen on this mission. The system is even capable of dropping a capsule full of troops, but it hardly is a preferred method of insertion. Troops generally prefer to be inserted via a stealth motor glider, which is airdropped from the SuperGalaxy, and then glide silently to insert an entire special operations force into precise locations.

Like troops, some payloads are especially sensitive to landing, and in these cases, there are several other specialized unmanned gliders that can be dropped. The Space-Saver motor glider is used to save space and extend range—it is stored, deflated, and powered by a short lifetime pulsejet similar to the old German *buzz bombs*. ¹⁰ These tiny engines have one or no moving parts. They are ignited as they drop and then slowly inflate a lightweight air-pressurized wing and tail, which is then GPS-guided to its eventual target. The advantage of such devices is that they can be used several times, and field users can use them to launch items out of the theater.

One or two such sorties are capable of supplying the entire expendable needs of the theater for a day. 11 The need for tails—at least for delivery—is greatly reduced. Because of the link to the common operational picture and the ability to deliver just in time directly, there is little need for on-the-ground warehousing, and often, it is literally as simple as the user's saying, "Need more bullets," to his terminal, and the aircraft saying, "Here you go." After all specified packages are dropped and all required resupply is filled, orders for *seconds* are taken and dropped before flying home and letting the next aerial resupply bomber take over.

How far away is this vision? The oblique all wing (OAW) platform envisioned above does not exist today, and it presently is not being developed within the Department of Defense, but its production is well within our nation's current technological capability.

While other platforms—such as more traditional span-loaders, blended-wing bodies, airships, and even conventional airlifters—certainly could be adapted to drop airlift as a bomber drops bombs and, perhaps, even offer equivalent payload and range, they likely would never equal the OAW in speed, stealth, or endurance.

The concept of the OAW was originated by the father of the sweptwing, the late National Aeronautics and Space Administration (NASA) engineer R. T. Jones, who first recognized the advantages of combining *the* most efficient aerodynamic shape with *the* most efficient wing loading.

Between 1952 and the present, NASA has conducted numerous studies on the oblique wing designs, including a

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passenger OAW design that could carry more than 300 passengers distances of 6,000 miles at speeds up to 1.6 mach.

The outstanding aerodynamics of OAW theory were validated both in wind-tunnel testing and in a radio-controlled scale-model UAV. Economic studies showed that even at supersonic airspeeds, this vehicle could be operated 30 percent cheaper than 747s carrying an equivalent load over the same distances and still land and take off on existing runways—with lower power at takeoff and less noise. ¹²

Seeking to find solutions to airport congestion, NASA studied the viability of a cruiser-feeder concept, where more traditional aircraft actually would land on top of the OAW and transfer cargo, passengers, and fuel. NASA concluded such a pairing would offer good flight characteristics and that there existed no technical showstoppers. Such capabilities further would offer advantage to an OAW design, creating entirely new possibilities for exfiltration and back lift.

Up until now, the OAW was unattractive *not* because of technical difficulties but because such an aircraft, with a wingspan of more than 500 feet, would force significant redesign of the existing infrastructure; was a radical departure in design for a market based on passenger confidence; and such a radical design would have little tooling in common with previous designs.

But military need, not passenger confidence, drives military airlift, and very large aircraft such as the AirBus 380 inevitably will drive changes to our future infrastructure to accommodate their larger wingspans. The problems engendered by the OAW's very large wingspan are primarily during ground operations—such an aircraft easily could land on existing runways, but their wings would overhang adjacent taxiways. If the OAW was operating primarily as an intercontinental strategic airdrop platform, it might only require one or two custom airfields to undergo significant redesign.

Considering the mix of stealth, range, speed, payload, and loiter and the fact that it has been so well studied and is clearly within our present technological reach, the OAW deserves a dedicated study by the Secretary of Defense Office of Transformational Strategists; Under Secretary of Defense for Advanced Systems and Concepts; Deputy Chief of Staff of the Air Force for Plans and Programs, Strategic Planning Directorate; US Transportation Command; and Air Mobility Command (AMC).

High-altitude precision airdrop is even nearer to reality. Recognized as a critical capability by the Joint Requirements Oversight Council, JPADS was approved for fast tracking¹⁴ by the Deputy Secretary of Defense for Advanced Systems and Concepts for Advanced Concept Technology Demonstrations¹⁵ and has demonstrated noteworthy success.

High-altitude precision airdrop is considered necessary to enable the Army's vision of a revolution in military logistics for the Army After Next, where it wishes to be able to insert a combat force—the interim brigade combat team (IBCT)—into a theater within 96 hours, even when limited by maximum on ground, ¹⁶ and afterwards to resupply these highly dispersed teams, fort to fighter, via a concept they call Integrated Logistics Aerial Resupply. ¹⁷ It, too, sees precision airdrop as the answer.

While JPADS packages are not yet in the type of disposable aerodynamic containers described above, JPADS-guided parafoils have demonstrated the capability to drop 10,000-pound

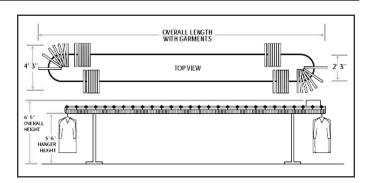


Figure 2. Coat Rack Loader

packages 25,000 feet from existing airlift platforms, landing with accuracy within the Army's required 100 meters of circle error probable and an offset up to 25 nautical miles.

Sophisticated new software integrates real-time wind data from numerous sources—GPS dropsondes, radar, and light distance and ranging—via an encrypted datalink, then calculates computed aerial release points, as well as probable landing areas for unguided or failed chutes. The JPADS team also has developed a concept of operations that closely mirrors the close air support model of providing resupply just in time rather than just in case. But most important, one commercially produced JPADS system, the Sherpa, already has been used operationally to resupply Camp Korean Village in Al Anbar Province, Iraq. On 9 August 2003, two Sherpa-guided parafoils were dropped from a Marine KC-130 more than 5 miles high and landed within 200 meters of the targeted drop point.¹⁸

While the current cost of expendables is extremely high—on the order of \$3-5 per pound—this cost must be balanced against the staggering cost and risk of building up, maintaining, and protecting aerial port and convoy delivery infrastructures on the ground (including loaders; fire and fuel trucks; petroleum, oil, and lubricant facilities; and lodging) and the fuel of landing and taking off for both the strategic and tactical airlifters. Building up and swapping out such infrastructures takes up a large portion of military lift as it is. Also, consider that airdrop expendables are much easier to budget for and replace than the platforms and personnel who drop them—the cost and trouble of high-altitude airdrop seem much more attractive when balanced against the loss of an aircraft and crew. What is needed now is for the Air Force to finalize and embrace the high-altitude precision airdrop concept of operations, approve the JPADS for operational use on Air Force aircraft, and begin studies and programming for a dedicated airdrop platform. The JPADS program, for its part, needs to continue for some time to come in order to improve the reliability, cost, accuracy, and payload for the current crop of platforms and begin design of the next-generation precision airdrop containment system, focusing on an order of magnitude reduction in cost and rigging complexity.

By unifying the capabilities of high-altitude precision airdrop with a dedicated intercontinental delivery platform, information infrastructure, and appropriate doctrine, the revolution in military affairs exemplified by the union of the B-2 and PGM could be expanded to create a revolution in military logistics allowing just-in-time delivery, from fort to fighter ultimately

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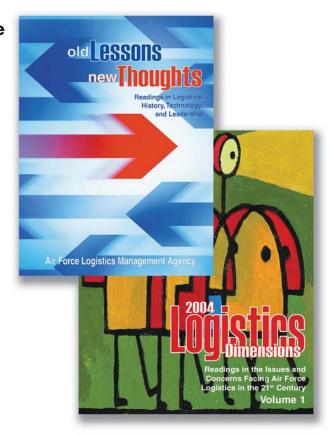
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